

REMARKS

In the last Office Action, the Examiner rejected claim 6 under 35 U.S.C. §103(a) as being unpatentable over Japanese Patent No. 62-183352 ("Japan '352) in view of U.S. Patent No. 3,054,709 to Freestone et al. ("Freestone") or U.S. Patent No. 4,224,101 to Tijburg et al. ("Tijburg"). Claim 7 was rejected under 35 U.S.C. §103(a) as being unpatentable over Japan '352 in view of Freestone or Tijburg and further in view of U.S. Patent No. 5,814,532 to Ichihara. Additional art was cited of interest.

In accordance with the present response, independent claim 1 has been amended to further patentably distinguish from the prior art of record and to overcome the rejection under 35 U.S.C. §112, second paragraph. Non-elected claims 4-5 and 8-12 have been canceled without prejudice or admission and subject to applicants' right to file a continuing application to pursue the subject matter of the non-elected claims. New claims 13-19 have been added to provide a fuller scope of coverage.

In view of the foregoing, applicants respectfully submit that the rejection of claim 6 under 35 U.S.C. §112, second paragraph, has been overcome and should be withdrawn.

Applicants respectfully request reconsideration of their application in light of the following discussion.

Brief Summary of the Invention

The present invention is directed to a method of manufacturing thermal heads.

The specification (pgs. 1-3) and drawings (Figs. 11-13) disclose conventional methods of manufacturing thermal heads. In the conventional methods, it has been difficult to manufacture plural thermal heads with high efficiency in a single manufacturing process. Furthermore, it has been difficult to accurately position an encapsulation (e.g., resin sealing structure) over integrated circuits of the thermal heads and to reduce the size of the encapsulation without compromising its protective performance.

The present invention overcomes the drawbacks of the conventional art. Figs. 5-9 show an embodiment of a method of manufacturing thermal heads according to the present invention embodied in the claims. A substrate 7 is provided having a first surface, a second surface opposite the first surface, a plurality of electrodes disposed on the first surface, and a plurality of pairs of heaters 2 disposed on the first surface so that the heaters of each pair of heaters are disposed in confronting, spaced-apart relation to one another (Fig. 5). Integrated circuits 51, 52 are mounted on the electrodes to provide a plurality of pairs of integrated circuits so that the integrated circuits of each pair are disposed in confronting,

spaced-apart relation to one another. The integrated circuits 51, 52 and the space between each pair of the integrated circuits 51, 52 are encapsulated with a resin 6. Thereafter, grooves are formed in one of the first and second surfaces of the substrate 7 to provide at least first and second groups of separating lines 7a, 7b so that the separating lines 7a of the first group are disposed between respective pairs of the heaters 2 and the second group of separating lines 7b are disposed in the space between respective pairs of the integrated circuits 51, 52. The substrate 7 is then cut along the first group of separating lines 7a formed by the grooves and along the second group of separating lines 7b formed by the grooves and through the encapsulating resin 6 to provide individual ones of the thermal heads each having one of the heaters 2, at least one of the integrated circuits 51, 52 for providing a drive signal to drive the heater 2, and a sealing element formed by the resin for protecting the integrated circuit.

By the foregoing method, a plurality of thermal heads are manufactured in a single manufacturing process with high efficiency. Furthermore, each of the thermal heads manufactured according to the present invention has a sealing element (i.e., protective encapsulation) which does not increase the overall size of the thermal head while providing the required protection to the integrated circuits.

Traversal of Prior Art Rejections

Claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over Japan '352 in view of Freestone or Tijburg. Applicants respectfully traverse this rejection and submit that the combined teachings of Japan'352, Freestone and Tijburg do not disclose or suggest the subject matter recited in amended independent claim 6.

Amended independent claim 6 is directed to a method for manufacturing thermal heads and requires the steps of providing a substrate having a first surface, a second surface opposite the first surface, a plurality of electrodes disposed on the first surface, and a plurality of pairs of heaters disposed on the first surface so that the heaters of each pair of heaters are disposed in confronting, spaced-apart relation to one another, mounting integrated circuits on the electrodes to provide a plurality of pairs of integrated circuits so that the integrated circuits of each pair are disposed in confronting, spaced-apart relation to one another, encapsulating the integrated circuits and the space between each pair of the integrated circuits with a resin, forming grooves in one of the first and second surfaces of the substrate to provide at least first and second groups of separating lines so that the separating lines of the first group are disposed between respective pairs of the heaters and

the second group of separating lines are disposed in the space between respective pairs of the integrated circuits, and cutting the substrate along the first group of separating lines formed by the grooves and along the second group of separating lines formed by the grooves and through the encapsulating resin to provide individual ones of the thermal heads each having one of the heaters, at least one of the integrated circuits for providing a drive signal to drive the heater, and a sealing element formed by the resin for protecting the integrated circuit. No corresponding combination of steps are disclosed or suggested by the combined teachings of Japan '352, Freestone and Tijburg.

The primary reference of Japan '352 discloses a method of manufacturing thermal heads. Electrodes 6, heaters 5, and integrated circuits 7 are disposed on a surface of a substrate 1. The integrated circuits 7 are in confronting, spaced-apart relation to one another. A sealing element 9 is disposed over each of the integrated circuits 7 for protecting the integrated circuits. Grooves 3 are formed on the substrate to form separating lines disposed between respective pairs of heaters 5 and between respective pairs of integrated circuits 7. The substrate 1 is cut along the separating lines (i.e., through cutting points 15) to provide a plurality of thermal heads having at least one of the heaters 5 and one of the integrated circuits 7.

However, Japan '352 does not disclose or suggest the step of encapsulating the integrated circuits and the space between each pair of the integrated circuits with a resin, as recited in amended claim 6. More specifically, in Japan '352 the sealing element 9 is clearly not formed in the space between each of the pairs of confronting and spaced-apart integrated circuits 7 (i.e., in the region denoted with numeral 3 corresponding to the grooves and numeral 15 corresponding the cutting points).

Furthermore, Japan '352 does not disclose or suggest the step of cutting the substrate along the first group of separating lines formed by the grooves and along the second group of separating lines formed by the grooves and through the encapsulating resin to provide individual ones of the thermal heads each having one of the heaters, at least one of the integrated circuits for providing a drive signal to drive the heater, and a sealing element formed by the resin for protecting the integrated circuit, as recited in amended claim 6. In Japan '352, the cuts clearly do not run through the sealing elements 9 because the sealing element 9 is not formed in the region along the cutting points 15 of the substrate 1.

Moreover, as recognized by the Examiner, Japan '352 does not disclose the two groups of separating lines recited in claim 6. With respect to these feature, the Examiner cited the

references of Freestone and Tijburg which disclose a plurality of group of separating lines in the production of integrated circuits. However, Freestone and Tijburg do not disclose or suggest the specific combination of steps recited in amended claim 6, including the step of encapsulating the integrated circuits and the space between each pair of the integrated circuits with a resin and the step of cutting the substrate along the second group of separating lines formed by the grooves and through the encapsulating resin. Since Freestone and Tijburg do not disclose or suggest these steps, they do not cure the deficiencies of Japan '352. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, applicants respectfully request that the rejection of claim 6 under 35 U.S.C. §103(a) as being unpatentable over Japan '352 in view of Freestone or Tijburg be withdrawn.

Claim 7 was rejected under 35 U.S.C. §103(a) as being unpatentable over Japan '352 in view of Freestone or Tijburg and further in view of Ichihara. Applicants respectfully traverse this rejection and submit that the combined teachings of Japan '352, Freestone, Tijburg and Ichihara do not disclose or suggest the subject matter recited in claim 7.

Japan '352 in view of Freestone or Tijburg does not disclose or suggest the subject matter recited in amended independent claim 6 as set forth above for the rejection of claim 6 under 35 U.S.C. §103(a). Claim 7 depends on and contains all of the limitations of amended independent claim 6 and, therefore, distinguish from the references at least in the same manner as claim 6.

The Examiner cited the reference to Ichihara for its disclosure of a step of forming grooves using a laser scribe. However, Ichihara does not disclose or suggest the specific combination of steps recited in amended claim 6, from which claim 7 depends, including the step of encapsulating the integrated circuits and the space between each pair of the integrated circuits with a resin and the step of cutting the substrate along the second group of separating lines formed by the grooves and through the encapsulating resin. Since Ichihara does not disclose or suggest these steps, it does not cure the deficiencies of Japan '352 as modified by Freestone or Tijburg. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, applicants respectfully request that the rejection of claim 7 under 35 U.S.C. §103(a) as being unpatentable over Japan '352 in view of Freestone or Tijburg and further in view of Ichihara be withdrawn.

Applicants respectfully submit that new claims 13-19 also patentably distinguish from the prior art of record.

Claims 13-15 depend on and contain all of the limitations of amended claim 6 and, therefore, distinguish from the references at least in the same manner as claim 6.

New independent claim 16 is directed to a method for manufacturing thermal heads. Claim 16 requires the steps of providing a substrate having a first surface and a second surface opposite the first surface, disposing a plurality of pairs of heaters on the first surface of the substrate so that the heaters of each pair of heaters are disposed in confronting, spaced-apart relation to one another, mounting a plurality of pairs of integrated circuits on the first surface of the substrate so that the integrated circuits of each pair of integrated circuits are disposed in confronting, spaced-apart relation to one another, encapsulating each of the pairs of integrated circuits and the corresponding space therebetween with a protective resin, and cutting the substrate from one of the first and second surfaces thereof along cutting lines disposed in the space between each of the pairs of heaters and along cutting lines disposed between each of the pairs of integrated circuits while cutting through the corresponding protective resin to provide individual ones of the thermal heads each having one of the heaters, at least one of the

integrated circuits for providing a drive signal to drive the heater, and a protective sealing element formed by the protective resin for protecting the integrated circuit. No corresponding combination of steps is disclosed or suggested by the prior art of record. For example, none of the cited references discloses the steps of encapsulating each of the pairs of integrated circuits and the corresponding space therebetween with a protective resin, and cutting the substrate from one of the first and second surfaces thereof along cutting lines disposed between each of the pairs of integrated circuits while cutting through the corresponding protective resin, as recited in independent claim 16, as set forth above for amended claim 6.

Claims 17-19 depend on and contain all of the limitations of independent claim 16 and, therefore, distinguish from the references at least in the same manner as claim 16.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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AUG 16 2004

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